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ABSTRACT

Long term studies of advance organizers (AO) were analyzed with Glass's meta-analysis technique. AO's were defined as bridges from reader's previous knowledge to what is to be learned. The results were compared with predictions from Ausubel's model of assimilative learning. The results of the study indicated that advance organizers were associated with increased learning and retention of the material to be learned. This was consistent with Ausubel's prediction. However, other variables associated with high "effect size" (ES) were not consistent with predictions by Ausubel's model. Four specific results contradicted the model. These were lower ES's associated with written-only and abstract AO's; higher ES's with non-subsuming AO's; lack of special facilitation for low ability, or low knowledge learners; and lower ES's for older learners. A modification of Ausubel's model may be needed to account for the positive effect of AO's demonstrated in this review. (DWH)

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A META-ANALYSIS OF ADVANCE-ORGANIZER STUDIES

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ABSTRACT

Twenty-nine reports yielding 112 studies were analyzed with Glass's meta-analysis technique, and results were compared with predictions from Ausubel's model of assimilative learning. Overall, advance organizers were shown to be associated with increased learning and retention of the material to be learned. Levels of some variables in the high-effect-size studies were not as predicted by Ausubel's model, however.

About twenty years ago, David Ausubel introduced his theory of meaningful learning. For Ausubel, learning of a new term is "meaningful" when the term can be correctly classified and arranged in the learner's memory and can thereby be retained for a long time. He hypothesized that new specific material is learned and stored in hierarchical form, with broader and more abstract previously-learned concepts subsuming more specific, new concepts (1).

Ausubel's corollary hypothesis is that reading short, introductory passages including "advance organizers" (AOs) will enable students to organize, learn, and retain the subsequently-read material to be learned. AOs are broadly defined as bridges from the reader's previous knowledge to whatever is to be learned; they are supposed to be more abstract and inclusive than the more specific material to be learned, and to provide a means of organizing the new material.

Ausubel's own early experiments with AOs showed that they did increase achievement on posttests over the material to be learned. Experiments by other investigators also supported Ausubel's model. Some later studies, however, failed to do so: students given AOs before the material to be learned did no better, or even worse than, students in control groups. In a review of 32 AO studies, Barnes and Clawson found that the studies having statistically nonsignificant results outnumbered studies with significant results, and they concluded that AOs as described by Ausubel do not facilitate learning (2).

Recently, other reviewers have evaluated AO studies by using the meta-analysis technique proposed by Glass(3). Luiten, Ames, and Ackerman (4) reviewed 135 published and unpublished studies and analyzed them with Glass's technique. They concluded that AOs facilitate both learning and retention. In another major review, Kozlow (5) examined 99 published and unpublished studies (calculating t-statistics instead of ES statistics) and reached the same conclusion. Both of these reviews noted the differing

effects of many variables. Such variables have arisen both from the usual sources in educational research and from the difficulty in applying Ausubel's general directions to specific situations.

In a voting-technique review, Mayer (6) compared the results of 44 published studies of AOs to predictions from reception and from assimilation learning theories. He found that the predictions from assimilation theory were confirmed; that is, that AOs had a stronger positive effect if learners lacked prerequisite skills or knowledge, if the learning material was poorly organized, or if generalized outcomes were measured.

The study described here was an attempt to combine the two approaches: to analyze long-term studies of AOs with the meta-analysis technique and to compare the results with some predictions from Ausubel's model of learning. If the model is correct:

1. Students given AOs should perform better on tests over the material to be learned than students in control groups do.
2. The AO-effect should be at least as great in longer studies as in shorter ones.
3. Abstract AOs should be more effective than those including concrete materials or analogies.
4. Subsuming AOs should be more effective than others.
5. The learning of students at the formal-operational level should be enhanced more than that of concrete-operational students.
6. AOs bridging the gap from previous knowledge should be more effective than overviews or summaries of the material to be learned.
7. Students having either low ability or low prior knowledge of the material should be helped more by AOs than other students are.

In addition to testing these predictions, the study was designed to evaluate the effects of other, possibly critical, variables such as subject matter and method of evaluation.

Methods

A computerized search of ERIC files for 1970-1980, a manual search of more recent indexes, and the bibliographies in articles from those sources yielded 166 reports on the subject of AOs. Many of these were excluded from analysis: 10 were duplicates of other studies, 13 failed to include sufficient data, 3 had no control group, 42 were not experimental studies, and 16 were not obtainable. In 54 studies the posttest or retention test was given less than a week after students read the material to be learned; for emphasis on long-term learning and for elimination of studies of trivial learning matter, these also also were excluded. My own unpublished study of AOs for high school biology was added, and additional data were obtained from some authors. Finally, 29 studies emerged for analysis with Glass's technique.

In a meta-analysis, the results of each study are expressed as an "effect size" statistic (ES):

$$ES = \frac{\bar{X}_e - \bar{X}_c}{SD_c}$$

($\bar{X}_e$ is the mean posttest score of the treatment group, $\bar{X}_c$ of the control group, and SD_c is the standard deviation of the control group).

By using these standardized statistics, one can both compare various types of studies that may not be comparable by other means and include studies yielding nonsignificant results in an overall analysis. An ES provides a more accurate representation of the results of each study than a "yes" or "no" vote. Finally, small but consistent effects across many studies, which would be obscured by the voting technique, can be detected.

The 29 studies were broken down to yield as many effect sizes as possible. Because many studies gave results for several treatment or subject variables or included substudies, 112 effect sizes were obtained.

In most cases it was possible to calculate the effect size from the means and standard deviations; in some, indirect methods outlined by Glass were used to calculate the SDc from the t-statistic or F-ratio.

For each ES obtained, information was recorded on the variables listed in Tables 1, 2, and 3. No attempt was made to obtain information about variables from authors. If an ES could not be classified on a variable from the published report, it was coded as "not specified."

Table 1 shows the means of ESs classified according to AO characteristics. Style refers to whether the AO was expository, comparative, a mixture of expository and comparative, or narrative. Hierarchy type refers to whether or not the AO subsumed the concepts to be learned. Some authors used AOs taken from the material to be learned, rather than from the gap between the learner's knowledge and what is to be learned; that classification is made under Source. The presentation mode is given under Medium; levels are written, written and illustrated, and "other" (aural, game, etc.). If the AO Sequence was given as leading to application of a formula or to generalization, it was so classified. Some AOs were conceptual only; others required students to perform tasks, with or without concepts being supplied. Those levels were included in Concepts or Processes. If concrete materials or analogies were part of the AO, it was so classified under Operational Level; if not, it was considered abstract.

In Table 2, results according to learner characteristics are given. Levels of Ability include several general measures, such as reading scores and intelligence quotients. Levels of Prior Knowledge refer to the learners' previous knowledge of the specific material to be learned.

Table 3 shows mean ESs for several conditions of learning. Evaluation type refers to whether the posttest was of the factual-recall (or formula-application) type, or if it measured generalized learning outcomes. All science and mathematics studies were

grouped together in Subject because of the difficulty in separating physical science from mathematics studies. The Length of Study ranged from 1 to 14 weeks, but the results have been grouped for comparison. When studies included both posttests and retention tests, the results for the retention tests were used for calculating the ESs.¹

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1. The validity of using 112 ESs from only 29 studies was established by using Tukey's jackknife test. The resulting confidence interval for the ES μ was [.38..97].

Results

Main effects. The median ES for all studies was 0.48 ($\bar{x}$ 0.66, SD 0.78, N 112). Not only was the overall ES greater than zero, but the effect was retained in longer studies, as seen in Table 3. (For comparison with other reviews, mean ESs are given. The median values, however, are probably better indicators.)

In summary, Table 1 indicates that higher ESs are associated with nonwritten or illustrated AOs; with an expository style; with non-subsuming AOs; with both AOs that bridge from previous knowledge and AOs that are taken from the material to be learned; with AOs that combine concepts and processes; with generalized AOs; and with concrete AOs.

As to the learning-conditions variables shown in Table 3, higher ESs are seen for the science-mathematics subject group than for other subjects. Higher ESs also were associated with factual (or formula) evaluations.

The only critical learner characteristic appears to be grade level; junior high school and preschool learners had higher mean ESs than other groups. Sex of learners may be a relevant variable also, according to these results, but the numbers of ESs available are too small for an inference to be made. Students classified as "not specified" as to ability or knowledge had the highest mean ES, followed by medium-ability students.

Interactions. In many cases, the small numbers of studies precluded studying interactions among variables. A few comparisons are possible, however, as shown in Table 4. When the AO includes concrete materials or analogies, the highest ESs are seen when the AO is conceptual only. On the other hand, abstract AOs have higher ESs when they include a combination of concepts and processes.

Contrary to what might be expected, factual or formula AOs

are associated with higher ESs when the evaluation is generalized; conversely, generalized AOs are associated with higher ESs when the evaluation tests for recall of facts or formulas.

Discussion

As other recent reviewers have found, using AOs to introduce new material to be learned does facilitate long-term learning. A mean difference of 0.66 SDs between experimental and control groups is not inconsiderable, and that difference did not decline in longer studies. The facilitation of factual learning by generalized AOs also is consistent with his model.

Other variables associated with high ESs, however, were not as predicted by Ausubel's theory. In particular, four results contradict the model: the lower ESs associated with written-only and with abstract AOs; the higher ESs with non-subsuming AOs; the lack of any special facilitation for low-ability or low-knowledge learners; and the lower ESs for older learners, who are more likely to be at the formal-operational level.

The interaction between concepts/processes and AO operational level seems especially interesting. Perhaps problem-solving or other active processing by the learner is essential when the AO is abstract, but not when it is concrete.

In general, predictions from the model proposed by Ausubel are not confirmed by these results. A modification of his model, or a different one, may be needed to account for the positive effect of AOs demonstrated in this and other reviews.

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Table 1. Classification of ES by AO characteristics.

Variable	Levels				
	Comparative	Expository	Mixture	Narrative	Not specified
Style					
median ES	0.48	0.68	0.32	0.29	0.38
mean ES	0.88	0.80	0.18	0.53	0.54
SD	0.93	0.76	0.42	0.85	0.64
N of studies	22	44	16	12	18
Hierarchy type		Not specified		Subsumers	Other
median ES		0.39		0.48	0.64
mean ES		0.64		0.65	0.71
SD		1.14		0.77	0.66
N of studies		15		82	15
Source		Not specified		Bridge	From material
median ES		0.02		0.57	0.65
mean ES		0.07		0.75	0.71
SD		0.35		0.83	0.50
N of studies		14		83	15
Medium		Written only	Written and illustrated		Other
median ES		0.34	0.40		0.68
mean ES		0.43	0.52		0.83
SD		0.72	0.89		0.75
N of studies		38	15		59
Sequence		Not specified	Factual		Generalized
median ES		0.36	0.41		0.67
mean ES		0.60	0.53		0.78
SD		0.90	0.51		0.71
N of studies		50	19		43
Operational level		Not specified	Concrete		Abstract
median ES		0.38	0.63		0.40
mean ES		0.24	0.80		0.58
SD		0.43	0.84		0.71
N of studies		15	61		36
Concepts or processes		Not specified	Concepts only	Processes only	Both
median ES		0.26	0.48	0.41	0.61
mean ES		0.12	0.69	0.60	0.67
SD		0.35	0.91	0.63	0.62
N of studies		3	57	15	37

Table 2. Classification of ES by learner characteristics.

Variable	Levels				
Sex	Not specified	Males	Females	Both	
median ES	0.48	0.11	0.73	0.46	
mean ES	0.64	0.21	1.02	0.67	
SD	0.92	0.62	0.92	0.71	
N of studies	28	6	6	72	
Grade level	Preschool	Elementary	Jr. high	High school	College
median ES	0.81	0.46	1.00	0.33	0.40
mean ES	1.01	0.64	1.39	0.45	0.49
SD	0.73	0.72	0.71	0.76	0.67
N of studies	24	18	6	42	12
Ability or knowledge level	Low ability		Medium ability		High ability
median ES	0.38		0.62		0.32
mean ES	0.26		0.64		0.34
SD	0.57		0.54		0.50
N of studies	13		12		10
	Low knowledge		Medium knowledge		High knowledge
median ES	0.33		0.32		0.26
mean ES	0.32		0.27		0.24
SD	0.54		0.18		0.37
N of studies	6		5		4
	Not specified as to ability or knowledge				
median ES	0.66				
mean ES	0.88				
SD	0.88				
N of studies	62				

Table 3. Classification of ES by learning conditions.

Variable	Levels				
Subject	Science or math			Other	
median ES	0.58			0.40	
mean ES	0.72			0.55	
SD	0.80			0.74	
N of studies	70			42	
Evaluation type	Factual or formula		Generalized		Not specified
median ES	0.63		0.46		0.39
mean ES	0.70		0.60		0.69
SD	0.84		0.71		0.83
N of studies	47		49		16
Length of study in weeks	1-3	4-6	7-9	10-12	13-15
median ES	0.41	0.30	-0.22	1.02	0.68
mean ES	0.59	0.37	-0.03	1.12	0.68
SD	0.80	0.39	0.35	0.77	0.45
N of studies	77	6	3	18	8

Table 4. Interactions affecting ES size.

		Concept or Process AO					
		Concept		Process		Both	
Operational level of AO	Concrete	median	0.86	median	0.41	median	0.50
		mean	1.10	mean	0.60	mean	0.64
		SD	1.05	SD	0.63	SD	0.66
		N	23	N	15	N	23
	Abstract	median	0.35	N 0		median	0.73
		mean	0.52			mean	0.81
		SD	0.76			SD	0.58
		N	23			N	11

		Evaluation type			
		Factual/formula		Generalized	
AO Sequence	Factual/ formula	median	0.28	median	0.45
		mean	0.43	mean	0.60
		SD	0.46	SD	0.57
		N	7	N	11
	Generalized	median	0.86	median	0.60
		mean	0.88	mean	0.55
		SD	0.82	SD	0.44
		N	25	N	16

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